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CONTENTS

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6. **Royal Meteorological Society. Phenological Committee.**
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ALATE APHIDES TRAPPED IN NORTH-WEST DERBYSHIRE, 1945

By L. Broadbent.

Rothamsted Experimental Station, Harpenden, Herts.

Traps were set up in the Peak District of Derbyshire in connection with a survey of aphides infesting potatoes. Only those aphides caught on the traps are dealt with in this paper; details of the survey will appear elsewhere.

Operations involved.—The traps were of a simple adhesive type, each consisting of a three-foot length of galvanised iron stove-piping, with an outer circumference of sixteen inches, giving a trapping area of four square feet. Each pipe was painted with white enamel and coated with a grease-banding substance which caught any insect flying into it, or alighting upon it; the grease preserved the aphides in good condition for periods up to a fortnight. The pipes were screwed to wooden posts so that the top of the trap was about six feet from the ground.

The traps were erected on 4th May, 1945, and were cleared of insects at intervals of about a week until 16th November, 1945. Normally all aphides were removed; when very high numbers were present, four two-inch or four one-inch strips were cleared and the catches multiplied by two or four respectively, to give an estimate of the numbers on the whole trap.

The aphides were later transferred to a mixture of equal parts of ethyl acetate and glacial acetic acid, and heated in a water bath until they were free from grease. The fluid was poured off and phenol added; after another period of about fifteen minutes in the water bath the aphides, now cleared, were stored in the phenol to await examination.

Location of the traps.—Six traps were set up in fields containing main-crop potatoes in the following localities:—

1. *Gladwin's Mark.* Altitude 1000 feet. Three miles north-east of Darley Dale in an exposed position on the gritstone ridge separating the Derwent valley from the Chesterfield industrial area. The trap was in the centre of twenty acres of potatoes, with cereal crops, grass, moorland, coniferous and mixed woodland in the vicinity.

2. *Bretton.* Altitude 1280 feet. One mile north-west of Eyam in an exposed position on the sharp gritstone ridge rising from the surrounding limestone and separating Bretton Clough from Middleton Dale. The trap was in the centre of fourteen acres of potatoes in similar surroundings to Trap 1.

3. *Chelmorton.* Altitude 1260 feet. Half a mile south-east of Chelmorton on a hillside with a westerly aspect. The trap was in the centre of three acres of potatoes surrounded by grass and a few fields of cereals. The flora of the area is typical of carboniferous limestone.

4. *Oaker.* Altitude 340 feet. In the Derwent valley, 200 yards from the river, one and a half miles north-west of Matlock. The trap was in a field containing one acre of potatoes and one of swedes, surrounded by cereals and grass and sheltered from the south-west by Oaker Hill.

5. *Hazelford.* Altitude 460 feet. One mile south-east of Hathersage, in the narrow part of the Derwent valley. The trap was on the river bank in a two-acre field growing potatoes, mangolds, swedes and kale. The river bank and the steep hillsides flanking the valley were covered with mixed woodland.

6. *Dore.* Altitude 400 feet. In the Sheaf valley, five miles south-west of the centre of Sheffield, in the middle of a residential area. The trap was in a small market garden, sheltered from the south-east by a steep, well-wooded hillside.

The season's results are summarised in the accompanying table. The first column gives the modern nomenclature (mainly after Börner and Schilder (1) and Ris Lambers (2, 3, 4, 5)). The names under which the species are described in Theobald (6) are given in the Appendix on p. 43. Columns two to seven give the season's catch for each species on each of the six traps and the eighth gives the total for each species for all traps. The ninth column indicates the periods over which the aphides were trapped for those species which have been identified, and the tenth the periods of peak migration where a marked increase of numbers occurred. The periods (1) to (4) in the last two columns refer to the dates 1–8, 9–16, 17–24, and 25–31 of the month.

Where it was not possible to separate the species from a consideration of the alatae apart from their host plants they have been grouped together, e.g. *Doralis fabae* Scopoli (group), *Doralis* Leach spp., *Yezabura* Matsumura and *Brachycaudus* Van der Goot spp. In other cases where the species is not recorded, either the aphis was damaged or it was not possible to assign the specimen to a known species. This was often the case with males.

Discussion.—It will be noted that the total number of aphides caught on each of the three traps situated at over 1000 feet was considerably less than the totals caught on the traps at lower altitudes. This was probably due to (*a*) the more sheltered conditions at lower altitudes being more favourable to general development and encouraging a greater amount of flighting; and (*b*) the greater variety of host plants and therefore of species at lower altitudes. The average of the minimum numbers of species recorded on the traps at high altitudes was 58, and for those at low altitudes it was 77.

That certain species were more abundant at lower altitudes was evident, *e.g.* the averages for catches on high and low traps in a few cases were :—

	High	Low
Hyperomyzus lactucae Linnaeus	8	29
Capitophorus similis Van der Goot . . .	18	50
Ovatus crataegarius Walker	10	37
Cavariella pastinaceae Linnaeus	28	128
Cavariella umbellatarum Koch	3	30

Some of the high counts recorded on the more sheltered traps were no doubt due to the close proximity of a dense colony. Such was the case in Trap 5 (Hazelford) where there was a bush of *Prunus padus* within ten yards of the trap. This bush was very densely infested with *Rhopalosiphum padi* Linnaeus, in September and October, and during the period 13th September to 16th October, 1012 females and 702 males of this species were recorded on the trap.

Certain species were not recorded from the traps at the higher altitudes, e.g. *Macrosiphoniella absinthii* Linnaeus, *M. millefolii* De Geer, *Megoura tribulis* Walker, *M. viciae* Kaltenbach, *Tuberolachnus salignus* Gmelin. Among those absent from the lower traps were *Macrosiphoniella sejuncta* Walker and *Thripsaphis cyperi* Walker. There is no reason to assume that the host plants of these species do not occur at all the altitudes at which the traps were situated, and further work, including field studies, would be necessary before drawing any conclusions as to the altitudinal distribution of these species.

It is noteworthy that certain species of economic importance occurred in similar numbers at all altitudes. Such was the case with *Macrosiphum solanifolii* Ashmead, *M.* (*Sitobion*) *avenae* Fabricius, *M.* (*Sitobion*) *fragariae* Walker, *Acyrthosiphon onobrychis* Boyer de Fonscolombe, *Metopolophium dirhodum* Walker, and *Myzus persicae* Sulzer.

Many species occurred in smaller numbers on Traps 5 (Hazelford) and 6 (Dore), compared with Trap 4 (Oaker) at a similar altitude, *e.g.* in the case of *Myzus persicae* Sulzer, 229 were recorded on Trap 4, compared with 22 and 85 on Traps 5 and 6 respectively. All these traps were near rivers, but Trap 4 was in an area of open ground in a wide valley, whereas the other traps were sheltered by trees and situated in narrow, steep-sided valleys. In these cases the air currents may have carried the majority of the aphides above the level of the traps.

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Appendix.

The following is Theobald's nomenclature (6) where this differs from the modern nomenclature in the table :—

1. *Panimerus* Laing spp.; 4. *Pterochlorus saligna* Gmelin; 8. *Euceraphis betulae* Linnaeus; 22. *Anuraphis helichrysi* Kaltenbach; 24. *Anuraphis crataegi* Kaltenbach; 25. *Anuraphis kochi* Schouteden; 26. *Anuraphis roseus* Baker; 27. *Anuraphis* Del Guercio spp.; 29. *Rhopalosiphum eriophori* Walker; 31. *Rhopalosiphum prunifoliae* Fitch; 34. *Aphis avenae* Fabricius; 36. *Aphis rumicis* Linnaeus partim; 39. *Aphis davidsoniella* Theobald; 40. *Aphis* L. spp.; 42. *Anuraphis* Del Guercio spp.; 43. *Toxoptera* Koch spp.; 44. *Hyadaphis xylostei* Schrank and *coniellum* Theobald; 45. *Hyalopterus atriplicis* Linnaeus; 46. *Capitophorus rosarum* Kaltenbach; 47. *Hyalopteroides pallida* Theobald; 50. *Cavariella capreae* Fabricius; 59. *Capitophorus ribis* Linnaeus and *whitei* Theobald; 65. *Phorodon crataegarium* Walker; 66. *Rhopalosiphoninus tulipaella* Theobald; 68. *Amphorophora cosmopolitanus* Mason; 69. *Amphorophora rhinanthi* Schouteden; 73. *Myzus lactucae* Schrank; 74. *Amphorophora aconiti* Van der Goot; 77. *Macrosiphum loti* Theobald; 78. *Macrosiphum pelargonii* Kaltenbach; 79. *Macrosiphum pisi* Kaltenbach; 80. *Macrosiphum dirhodum* Walker; 81. *Myzus festucae* Theobald; 82. *Myzus pseudosolani* Theobald; 83, 84 and 86. *Macrosiphum gei* Koch partim; 87. *Macrosiphum granarium* Kirby; 88. *Macrosiphum rubiellum* Theobald; 89. *Macrosiphum achilleae* Koch; 92. *Macrosiphum tussilaginis* Walker; 94. *Macrosiphoniella*

APHIDES TRAPPED IN N.W. DERBYSHIRE, 1945.

No.	Locality: / Altitude: / No. of trapping days:	1 Gladwin's Mark 1000 ft. 181	2 Bretton 1280 ft. 197	3 Chelmorton 1260 ft. 197	4 Oaker 340 ft. 197	5 Hazelford 460 ft. 197	6 Dore 400 ft. 197	Total	Periods of flighting	Peak periods of flighting
	Aphides unidentified:	5	1	2	—	7	—	15		
	Aphides unidentifiable:	6	2	10	6	11	7	42		
No.	Modern nomenclature								Numbers (1)–(4) refer to the weeks of the month.	
1	*Cinara* spp.	3	—	—	—	3	—	6		
2	*Eulachnus agilis* Kalt.	—	4	—	4	—	3	11	June (3); Aug. (4)–Sept. (4).	
3	*Schizolachnus tomentosus* de Geer	—	1	—	4	12	—	17	June (3)–Aug. (1).	
4	*Tuberolachnus salignus* Gmelin	—	—	—	—	1	2	3	Oct. (4)–Nov. (2).	
5	*Lachnus* spp.	2	—	—	—	—	—	2		
6	*Thripsaphis cyperi* Wlk.	2	2	—	—	—	—	4	July (4)–Aug. (2).	
7	*Symydobius oblongus* Heyd.	—	—	—	—	—	2	2	July (2).	
8	*Euceraphis nigritarsis* Heyd.	9	5	1	10	14	28	67	May (4)–Oct. (4).	
9	*Phyllaphis fagi* L.	2	—	1	1	—	2	6	June (4); Sept. (2)–Oct. (4).	
10	*Drepanosiphum platanoides* Schr.	23	72	49	75	421	401	1041	May (4)–Nov. (2).	June (1)–(3).
11	*Callipterus* spp.	1	1	—	—	—	1	3		
12	*Myzocallis* spp. (*annulata* Hartig & others)	3	2	1	7	17	18	48	June (3)–Oct. (4).	
13	*Therioaphis tiliae* L.	—	—	—	—	—	4	4	July (1)–(4).	
14	*Sipha* spp.	—	—	1	—	—	4	5		
15	*Atheroides hirtellus* Hal.	—	—	1	—	—	—	1	Aug. (4).	
16	*Chaitophorus abnormis* Theo.	—	—	1	—	—	—	1	Sept. (2).	
17	*Chaitophorus* spp.	1	—	—	—	2	1	4		
18	*Periphyllus aceris* Koch & *testudinatus* Thornt.	—	5	2	14	8	11	40	May (4)–June (3); Sept. (4)–Oct. (4).	May (4)–June (1).
19	*Periphyllus* spp.	—	—	1	—	—	—	1		
20	*Coloradoa* spp.	4	—	—	—	—	—	4		
21	*Pterocomma* spp.	—	2	—	2	—	2	6		
22	*Brachycaudus helichrysi* Kalt.	37	48	28	58	60	136	367	May (4)–Oct. (1).	
23	*Brachycaudus rumexicolens* Patch	19	17	10	12	6	91	155	May (4)–Sept. (2); Oct. (2).	July (3).
24	*Yezabura crataegi* Kalt.	—	1	1	—	3	—	5	Aug. (4)–Sept. (3).	
25	*Yezabura pyri* B.d.F.	2	—	—	—	—	4	6	July (2).	
26	*Yezabura malifoliae* Fitch	1	1	4	4	6	14	30	May (4)–Aug. (2); Sept. (2)–Nov. (2).	
27	*Yezabura* & *Brachycaudus* spp.	8	5	2	5	26	8	54		
28	*Anuraphis subterranea* Wlk.	—	—	—	—	1	—	1	Aug. (4).	
29	*Ceruraphis eriophori* Wlk.	13	6	—	4	122	40	185	June (1); Sept. (2)–Oct. (4).	Oct. (1)–(2).
30	*Hyalopterus arundinis* Fab.	69	22	35	217	90	55	488	June (2)–Sept. (2).	July (2)–(3).
31	*Rhopalosiphum crataegellum* Theo.	117	252	418	266	1987	378	3418	May (4)–Nov. (2).	Sept. (3)–Oct. (1).
32	*Rhopalosiphum maidis* Fitch	—	12	—	18	—	—	30	June (3)–July (4); Sept. (2).	
33	*Rhopalosiphum nymphaeae* L.	1	—	1	—	7	4	13	July (4)–Sept. (4).	
34	*Rhopalosiphum padi* L.	77	122	59	155	1855	396	2664	May (4)–Nov. (2).	Sept. (2)–Oct. (2).
35	*Aphis sambuci* L.	11	9	1	20	21	16	78	June (2)–Sept. (2).	July (2)–(3).
36	*Doralis fabae* Scop. (group)	50	47	54	228	321	309	1009		
37	*Doralis idaei* V. d. Goot	—	—	—	—	2	—	2	June (4).	
38	*Doralis laburni* Kalt.	—	—	—	—	—	4	4	Aug. (2)–(4).	
39	*Doralis rumicis* L.	—	2	—	8	10	—	20	July (2)–Sept. (1).	
40	*Doralis* spp.	11	8	—	34	65	103	221		
41	*Brevicoryne brassicae* L.	4	5	2	20	5	24	60	July (2)–Sept. (4).	
42	*Brachycolus* spp.	—	—	—	—	2	—	2		
43	*Schizaphis* spp.	—	—	—	—	1	—	1		
44	*Hyadaphis coniellum* Theo.	3	—	—	12	4	2	21	June (3)–Aug. (3).	
45	*Semiaphis atriplicis* L.	3	—	—	3	—	2	8	July (4)–Sept. (1).	
46	*Myzaphis rosarum* Kalt.	2	—	—	2	—	8	12	June (2)–(4); Aug. (2).	
47	*Hyalopteroides dactylidis* Hayhurst.	—	1	—	3	—	2	6	June (2)–July (1).	
48	*Cavariella aegopodii* Scop.	307	119	151	2424	291	713	4005	May (4)–Sept. (4).	July (2).
49	*Cavariella archangelicae* Scop.	—	—	—	—	1	—	1	June (1).	
50	*Cavariella pastinaceae* L.	15	14	54	97	216	70	466	May (4)–Sept. (2); Oct. (4)	
51	*Cavariella umbellatarum* Koch	1	—	7	13	47	30	98	May (4)–Sept. (1).	
52	*Liosomaphis berberidis* Kalt.	—	—	—	—	—	4	4	June (3)–(4).	
53	*Neomyzaphis abietina* Wlk.	—	—	—	1	—	—	1	June (1).	
54	*Capitophorus hippophaes* Wlk.	5	14	14	20	26	100	[illegible]	[illegible]	

57	*Phorodon humuli* Schr.	1	—	—	8	—	5	14	June (2)–July (3); Oct. (4).	
58	*Phorodon menthae* Buckt.	1	—	—	1	12	—	13	Sept. (2)–(4).	
59	*Cryptomyzus ribis* L. & *galeopsidis* Kalt.	16	17	39	39	2	13	126	May (4)–Aug. (4); Sept. (3).	July (3).
60	*Myzus ascalonicus* Donc.	18	10	11	7	5	10	61	May (4)–June (4); Oct. (2)–Nov. (2).	
61	*Myzus cerasi* Fab.	6	—	1	—	1	5	13	June (4)–July (4); Sept. (4)–Oct. (1).	
62	*Myzus persicae* Sulz.	105	82	76	229	22	85	599	June (3)–Nov. (2).	July (2)–Aug. (2).
63	*Myzus ranunculinus* Wlk.	3	15	4	4	4	2	32	Sept. (1)–Oct. (1).	
64	*Myzus* spp.	—	—	2	2	2	—	6		
65	*Ovatus crataegarius* Wlk.	24	3	4	35	8	54	128	June (1)–Aug. (2).	
66	*Rhopalosiphoninus staphyleae* Koch.	2	1	—	6	—	2	11	June (3)–Aug. (2).	
67	*Amphorophora rubi* Kalt.	3	—	—	3	1	6	13	May (4)–July (1).	
68	*Hyperomyzus lactucae* L.	8	7	9	53	7	28	112	May (4)–Aug. (1); Oct. (1).	
69	*Hyperomyzus rhinanthi* Schou.	—	—	6	—	—	—	6	Aug. (2)–(4).	
70	*Amphorophora* spp.	14	1	8	35	8	2	68		
71	*Rhopalomyzus* spp.	—	—	—	3	1	—	4		
72	*Wahlgrenia nervata* Gill.	6	—	1	—	—	2	9	July (1)–(2).	
73	*Nasonovia ribicola* Kalt.	12	13	6	20	6	17	74	May (4)–Nov. (2).	
74	*Delphinobium aconiti* V. d. Goot.	—	—	—	—	—	7	7	July (3)–Sept. (2).	
75	*Megoura tribulis* Wlk.	—	—	—	1	1	4	6	June (4)–Aug. (2).	
76	*Megoura viciae* Kalt.	—	—	—	1	2	12	15	June (4)–Aug. (3).	
77	*Acyrthosiphon loti* Theo.	—	5	3	—	—	2	10	June (1)–Aug. (1).	
78	*Acyrthosiphon malvae* Mosley & *Metopolophium* spp.	4	2	2	8	—	10	26	May (4)–July (3).	
79	*Acyrthosiphon onobrychis* B.d.F.	641	539	379	420	85	245	2309	June (2)–Oct. (4).	July (2)–(3).
80	*Metopolophium dirhodum* Wlk.	629	360	376	962	157	131	2615	June (2)–Oct. (2).	July (2)–(3).
81	*Metopolophium festucae* Theo.	29	39	30	70	16	30	214	May (4)–Aug. (3).	June (2)–(4).
82	*Aulacorthum solani* Kalt.	—	—	—	7	4	—	11	June (1)–(2); July (3).	
83	*Macrosiphum cholodkovskyi* Mordv.	—	—	—	—	1	—	1	July (1).	
84	*Macrosiphum gei* Koch.	—	4	—	—	—	2	6	June (1)–(4); Aug. (1)–(2).	
85	*Macrosiphum rosae* L.	—	4	5	10	13	21	53	June (2)–Oct. (4).	July (2)–(3).
86	*Macrosiphum solanifolii* Ash. (= *euphorbiae* Thomas)	10	—	4	12	10	18	54	June (2)–Sept. (4).	
87	*Macrosiphum* (*Sitobion*) *avenae* Fab.	132	134	67	125	22	125	605	June (1)–Oct. (1).	July (3).
88	*Macrosiphum* (*Sitobion*) *fragariae* Wlk.	22	14	8	33	12	48	137	May (4)–Nov. (2).	June (2); July (3)–Aug. (1).
89	*Dactynotus achilleae* Koch.	1	9	—	1	1	5	17	June (4)–Aug. (3); Oct. (1)–(2).	
90	*Dactynotus jaceicola* H.R.L.	—	5	—	—	2	2	9	July (2)–(3); Sept. (1)–(3).	
91	*Dactynotus pilosellae* Börner	—	—	—	4	—	—	4	July (3).	
92	*Dactynotus tussilaginis* Wlk.	2	—	—	—	2	1	5	Aug. (2)–(4).	
93	*Dactynotus* spp.	—	—	—	—	—	4	4		
94	*Dactynotus* (*Uromelan*) *campanulae* Kalt.	—	—	1	—	—	—	1	Aug. (4).	
95	*Dactynotus* (*Uromelan*) *taraxaci* Kalt.	—	—	10	2	—	10	22	June (3)–Sept. (1).	
96	*Microlophium carnosum* Buckt.	8	—	2	53	2	6	71	June (2)–July (4).	July (2).
97	*Macrosiphoniella abrotani* Wlk.	—	—	—	2	—	—	2	June (3).	
98	*Macrosiphoniella absinthii* L.	—	—	—	4	6	—	10	July (2)–(3); Aug. (4).	
99	*Macrosiphoniella millefolii* De Geer	—	—	—	1	6	—	7	June (4)–July (3).	
100	*Macrosiphoniella sejuncta* Wlk.	2	4	—	—	—	—	6	June (3)–July (3).	
101	*Macrosiphoniella* spp.	—	—	—	1	—	—	1		
102	*Thelaxes dryophilus* Schr.	1	—	3	2	4	14	24	June (1)–July (4).	
103	*Anoecia corni* Fab.	6	6	1	7	9	12	41	June (3); Aug. (3)–Oct. (1).	
104	*Pemphigus bursarius* L.	1	—	3	6	14	21	45	Aug. (1)–Oct. (4).	
105	*Pemphigus filaginis* Fons.	2	—	—	1	4	—	7	July (2)–Sept. (3).	
106	*Pemphigus* spp.	—	—	2	—	8	4	14		
107	*Prociphilus crataegi* Tull.	—	—	—	—	8	—	8	Aug. (3)–Oct. (4).	
108	*Thecabius affinis* Kalt.	8	5	4	13	17	21	68	June (3)–Oct. (1).	
109	*Eriosoma lanigerum* Hausm.	—	—	2	7	3	7	19	June (4)–July (2); Aug. (3)–Nov. (2).	
110	*Eriosoma lanuginosum* Hartig.	—	—	—	—	—	1	1	Sept. (4).	
111	*Eriosoma patchae* Börner	—	8	—	1	14	4	27	June (2)–(4); Aug. (1)–Oct. (2).	
112	*Eriosoma ulmi* L.	2	2	—	39	18	42	103	June (2)–(4); Oct. (1).	June (2)–(3).
113	*Eriosoma* spp.	—	—	—	1	1	—	2		
114	*Tetraneura gallarum* Gmelin	—	3	—	—	6	6	15	July (1)–Oct. (1).	
115	*Acaudella rubida* Börner	—	—	—	—	1	—	1	Sept. (2).	
	Total numbers of aphides trapped :	2560	2110	1994	6024	6230	4122	23,040		
	Minimum number of species represented :	62	55	56	74	76	81	—		

campanulae Kaltenbach; 95. *Macrosiphum taraxaci* Kaltenbach; 96. *Macrosiphum urticae* Schrank; 97. *Macrosiphoniella pulvera* Walker; 100. *Macrosiphum sejunctum* Walker; 102. *Vacuna dryophila* Schrank; 111. *Eriosoma ulmosedens* Mordvilko; 114. *Tetraneura ulmifoliae* Baker.

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THE LARVA OF *SYMPETRUM FONSCOLOMBII* (SELYS) (ODONATA—LIBELLULIDAE)

By Cynthia Longfield, F.R.E.S.

On the 30th August 1945, Messrs. W. J. Le Quesne and R. Dobson found freshly emerged imagines and quantities of exuviae of *S. fonscolombii* (Selys) at a canal near St. Ouen's Pond, Jersey, in the Channel Islands. On the 2nd and 4th September they took some live nymphs and later bred out the perfect

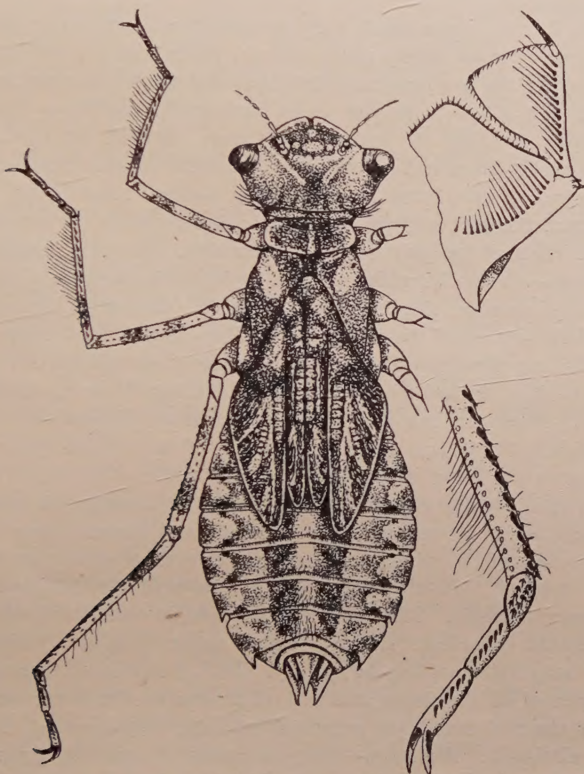


Fig. 1.—Last instar nymph of *Sympetrum fonscolombii* Selys. Inset are shown the labial mask as seen from the inner side, and the mid tibia and tarsus enlarged.

dragonfly. One full-grown nymph in spirit and several exuviae were sent to me at the British Museum and it is from the spirit specimen that this description of the first authentic European larva of *S. fonscolombii* has been made. Immature imagines had been taken by Le Quesne in Jersey in 1940 and 1941.

In 1929 Dr. C. K. Brain published a photograph of a nymph of *S. fonscolombii* in his book *Insect Pests and their Control in South Africa.* It so resembled a *Crocothemis* Brauer nymph that Dr. K. H. Barnard queried the identification (1937, *Ann. S. Afric. Mus.* **32** : 251). However, in 1940 Dr. Barnard bred the species himself from Cape Province nymphs and published the first description, basing it on a comparison with the larva of *Crocothemis erythraea* (Brullé)

(1940, *Ann. S. Afric. Mus.* 32 : 659). As these South African publications may not be available to many European odonatists, I have thought it of sufficient interest to publish a fuller description. This is accompanied by Col. F. C. Fraser's beautiful drawing, which he so kindly made for me from the Jersey specimen, a female nymph in the last instar, deposited in the British Museum.

Nymph.—Length 18 mm., breadth 6 mm. Colour olivaceous (Le Quesne *in litt.*), but fulvous in spirit, with a pattern in dark sepia on the upper surface, entirely unmarked on the underside. It seems most closely to resemble the shape of the nymph of *S. sanguineum* (Müller), but has shorter legs. The mid-dorsal hooks [medio-dorsal projections] are entirely absent and there are only exceedingly small, lateral abdominal spines on the 8th and 9th segments.

Head.—Width 5 mm. Eyes small, very prominent and set at the fore corners. The ocelli distinct. Antennae set widely apart and of 7 joints, the first two short and swollen, $\frac{1}{4}$ mm. each in length; the five terminal joints long and slender, measuring together 3 mm. Occiput sloping, with a few long, pale hairs posteriorly. *Labium.*—Spoon-shaped, triangular, completely covering the underside of face. Length 4·5 mm., width 4 mm., narrowing rapidly at the hinge and extending to the middle coxae. Median lobe of mentum fairly obtuse, entire. Mental setae 18 either side. Lateral lobes [palpi] triangular, with distal border almost straight, slightly crenulated; inner border convex and outer border slightly concave. Lateral [palpal] setae 14 either side. Movable hooks small and very slender. *Prothorax.*—Collar-like with two dark sepia bands along the dorsal surface and a dark mark low down on either side. *Thorax.*—A broken dark sepia band along either side, continuing the dark pattern of the prothorax. Wing-cases of hind-wings reaching to the 7th segment and lying parallel. The generic number of antenodals can be seen under a microscope. *Leg.*—Slender and moderately long, hind legs 15 mm., middle legs 12 mm., fore legs 10 mm. There are two dark sepia bands on the femora and one on the tibia. Through the cuticle of the tibia is to be seen one row of stout black spines, while there are two rows showing on the joints of the tarsus, and the centre of the larval claws show dark with the shorter, black, double claws of the imago showing through the transparent cuticle. The larval leg armature is interesting. Drs. Calvert [1] and Barnard have both pointed out the generic importance of the spines or setae. Some are fixed, strong and black, and these I prefer to call " spines." Others are movable, simple or divided into two or more prongs and are colourless and fragile. They also seem capable, in some cases, of being shed and I consider they should be called " divided setae," rather than the " divided spines " of Barnard. They may quite possibly be sensory. In *S. fonscolombii* there are divided setae on the lower apex of all the tibiae and in 1 of 2 rows on the lower surface of the fore and hind tarsi; the 2nd row being composed of long, simple setae. The setae on the middle tarsi are all simple. *Abdomen.*—Shape, a truncated oval, slightly arched and pubescent, but with no mid-dorsal hooks [medio-dorsal projections] whatever. The lateral abdominal spines on the 8th and 9th segments are acute, but exceedingly short, especially the 8th. There are two wide, dark sepia bands down the dorsal surface and sepia spots laterally. *Anal appendages.*—Moderately short and very hairy. Appendix dorsalis [median appendage] triangular and acute; the cerci [inferior appendages] half as long again as the appendix dorsalis; the cercoids [lateral appendages] three-quarters as long as the latter. Greatest length $1\frac{3}{4}$ mm.

[1] 1927, *Univ. Iowa Studies nat. Hist.* 12 (2) : 15.

CAPTURE OF BUTTERFLIES IN GREAT NUMBERS BY THE GRASS *SETARIA VERTICILLATA* (L.) BEAUV. IN EAST AFRICA

By Professor G. D. Hale Carpenter.

Mr. T. H. E. Jackson, F.R.E.S., of Kitale, Kenya Colony, recently wrote to me as follows: " I am sending by next post a box containing samples from an interesting ' butterfly trap ' at Marsabit. The trap was a grass growing round the mission station and it had caught literally thousands of butterflies. The occurrence gave irrefutable proof of the recognition of individual insects by members of their own species, I presume by colour vision. I examined hundreds of ' traps ' and only in the few examples sent were more than one species found in the same trap. Even in the case of the Acraeas, which are similarly coloured, the rule held. I made a definite search for exceptions to the rule and send *all* I found, whereas hundreds of examples proving the rule had, of course, to be left."

The material received consisted of a felted mass of the grass in which dozens of male *Acraea zetes* L., probably of the form *rudolfi* Eltringham, were inextricably tangled, and often torn to shreds. A few smaller pieces, sent separately, had captured perhaps a score of equally tattered *Acraea orina* Hewitson; there were also remains of one male and one female of *Acraea a. admatha* Hewitson, one *Danaus chrysippus dorippus* Klug, and one *Papilio demodocus* Esper, probably male. Pieridae were represented by two or three *Anapheis* and two *Dixeia* Talbot, the species being unrecognisable with certainty as the specimens were torn to bits.

Samples of the grass were sent to Mr. H. K. Airy-Shaw at Kew, as being interested in entomology as well as botany. He kindly consulted Mr. C. E. Hubbard, who reported that it was a form of *Setaria verticillata* (L.) Beauv., widespread in tropical Africa and most frequently encountered around native villages and in old cultivations. " The butterflies are trapped by the retrorsely barbed rigid bristles (sterile branchlets) of the inflorescences."

These barbs are responsible for the distribution of the seeds and an account will be found in " Kew Bulletin " (**1928**: 384) of how the Wasukuma in Tanganyika Territory use bunches of the dried inflorescences to protect the mouths of their grain stores against rats, which are thereby deterred from penetrating to the grain, as the inflorescences so firmly attach themselves to their fur.

The point that struck me was *why* the butterflies should visit the plant, and the great preponderance of males of *Acraea zetes* suggested that possibly the flowers might emit an odour deceptively like that of the female butterfly. Enquiries to this effect, however, produced a reply from the botanists that there was no evidence of such secretion by this grass but that viscous glands are known in quite a number of grasses, especially species of the large genus *Eragrotis*. It is quite obvious, however, that the capture is by hooked bristles and not by any adhesive.

Mr. Airy-Shaw kindly wrote again that he had " discussed the matter further with my colleagues C. E. Hubbard and E. Milne-Redhead, and also with Mr. Jan Gillett of South Africa. The most plausible suggestion that emerged was that possibly the butterflies were engaged at the time in a long-

distance migration and had settled for the night on a convenient patch of vegetation."

But *Acraea zetes* is most definitely *not* a migratory species. The pre-eminent migrants are species of *Anapheis* Hübner which were represented by one or two specimens only. There is a possibility, which Mr. Airy-Shaw finally suggested, that a single specimen of a female might have been trapped and that males were then attracted to her, and each other, with cumulative results. It was also pointed out that attractive plants might have been growing among the grass.

I have searched literature for records of a similar occurrence without any success at all. Lowe (1871, *A natural history of British Grasses*) says it is a doubtful British plant but is native of western Europe, Italy, North Africa, United States of America, and Asia. Marloth (1915, *Flora of South Africa* **4** : 19) gives it the name of "klits-grass" and says it is common near many outspan places of the eastern and northern districts. Symonds (1886, *Indian Grasses* : Madras) says cattle will not eat it, so it is considered a troublesome weed wherever found : common about rubbish heaps all over India. Coote (1906, *Flore de France* **3** : 548) says it occurs in temperate and subtropical regions of almost the whole globe.

It is hoped that further observations from other localities may throw light on this queer occurrence. I find it difficult to believe that the masses of butterflies on the grass were attracted simply by the presence of their own male kind. It is of course well known that a species can show some degree of recognition by sight : see, for example, the experiments by H. Eltringham in his paper on Butterfly Vision (1919, *Trans. ent. Soc. Lond.* **1919** : 44–7). But I had a long acquaintance with *A. zetes* in East Africa, and do not remember at any time seeing a large assemblage produced in this way.

C. B. Williams (1945, *Entomologist* **78** : 37–8) has recorded the capture of miscellaneous insects by the grass *Cenchrus myosuroides* H.B.K., closely allied to *Setaria*.

Postscript.

A further note has been received from Mr. Jackson, in response to enquiries. "10th July, 1946. There was definitely no migration and equally certainly the grass was not attractive to females. The three species of *Acraea* were behaving according to habit, *i.e.* flying slowly round the clearings in great numbers and coming down to various flowering plants to feed. It was, I think, merely a colour bait; an insect would get caught inadvertently by the grass, and others would be attracted to it by vision. I feel certain also that it is a regular occurrence and no exceptional observation; the grass was present in masses everywhere, for a native's plot had gone out of cultivation. I think the lack of females is due, as usual, to their different habits and habitats : the grass grows in open patches and females stay mostly in more shady places."

I am indebted to Mr. C. L. Collenette, F.R.E.S., for a reference to Pieridae being similarly caught, but probably on migration, and to some experiments conducted by him (1945, *Entomologist* **78** : 129–30).

OBSERVATIONS ON EAST AFRICAN PAMPHAGINAE (ORTHOPTERA, ACRIDIDAE) WITH PARTICULAR REFERENCE TO STRIDULATION

By E. Burtt, Ph.D., D.I.C., F.R.E.S.

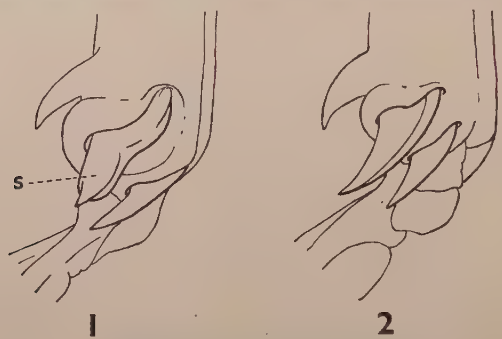
The East African Pamphaginae comprise only the two genera *Saussurea* Uvarov, and *Lamarckiana* Kirby. In both, the females are apterous, whereas the males are fully winged. In the latter sex the elytra are some shade of brown or greyish, rather broad, and of a delicate texture. The sound produced by stridulation is characteristic. From a distance it recalls to mind the grating noise from a whirling rattle. It is often difficult to know exactly from which direction the sound emanates; sometimes it is audible at a distance of several hundred yards. How this peculiar stridulation is produced has not been recorded.

In Tanganyika Territory, during 1935–1936, I found *Saussurea* associated with thorn bush (*Commiphora*, *Combretum*, *Acacia* spp. dominant) as exemplified by the immediate vicinity of Old Shinyanga and the eastern part of the Iramba Plateau, or the Ndorumo River Valley lying respectively north-east and north of Singida. On the other hand, *Lamarckiana* appeared to be chiefly associated with the vegetation community known as " miombo " (*Isoberlinia–Brachystegia*) in areas where it is broken up by settlement. In November 1935, numbers of *Lamarckiana loboscelis* Schaum were found in the Rift Valley, south-east of Singida. It was noticed that stridulation frequently occurred during the night —a most unusual feature for a member of the Acrididae. Between 1939 and 1945 a species of *Lamarckiana* (probably also *loboscelis*) was abundant in the area round Tinde, 25 miles south-west of Shinyanga, where most of the observations recorded in this paper were made. A male and a female are shown in Plate 1, figs. 1 and 2. In this area, also, stridulation frequently took place at night.

The sound was most in evidence during the late dry season (September–November), but continued to be heard less frequently until mid-December (early short rains), after which only very sporadic instances occurred before the next generation of adults appeared some two and a half months later. Males were occasionally seen on the wing when it was almost dark, flying low over the herbage. During the day both sexes were to be found resting motionless on the Euphorbiaceous shrub known as " Manyara " (*Euphorbia tirucalli* L.). This proved an excellent food on which to maintain them. They were kept either singly or in numbers together in gauze-sided wooden boxes of about 1 cu. ft. capacity, or in empty four-gallon tins covered with gauze and containing a 3-inch layer of sandy soil at the bottom. Captive specimens were sluggish and moved about very little. Feeding was mainly nocturnal and pairing took place readily. When roughly handled the insect often adopted what might be interpreted as a defensive or frightening attitude. The antennae were held motionless, drooping, and splayed apart at an angle of 40 degrees. The hind legs were moved so that the femora were rubbed against the elytra (♂), or against the side of the humped-up body (♀), on the downward stroke, producing a very audible " swishing " noise. This movement was made in violent spasms, and on each occasion the entire insect was jerked forward slightly. It might be repeated a dozen times, roughly once a second, in which case the total horizontal displacement would amount to about 5 cms.

Stridulation.—Stridulation is effected only by the adult male. When

ready to perform the insect may adopt the horizontal position shown in Plate 1, fig. 1, though a more or less vertical position on a twig, with the head uppermost, is more frequent. It rests on the front and middle pairs of legs, the body being held at a slight angle. The hind femora are held a little forward of the vertical and splayed outwards from the body. The distal end of the tibia thus comes to be poised approximately 3 mm. from the surface of the elytron. The hind tarsi are turned outwards at some 30 degrees from the median axis. While one of the spurs at the distal end of the tibia on the mesial side is normal, the other is modified as shown in text-fig. 1. In the female the corresponding spurs are both normal, as shown in text-fig. 2. At the base of the subcostal field of the elytron there is a specially modified oval-shaped area indicated in Plate 1, fig. 1 (a well-known characteristic in this group of PAMPHAGINAE). It bears strongly raised parallel veinlets running obliquely and acts as a rasp. Its form is



Lamarckiana sp. (from Tinde).

FIG. 1.—Mesial aspect of distal portion of posterior left tibia of male showing the specialised inner spur (S) (× 15).

FIG. 2.—Mesial aspect of distal portion of posterior left tibia of female showing both spurs normal (× 15).

shown in Plate 1, fig. 3. Tinde specimens were observed to stridulate when the terminal spur was scraped backwards and forwards across this rasp, analogous with the action of a plectrum. The rate of movement was about six complete (backwards and forwards) strokes per second. Femur and tibia were both in motion, the limbs on both sides being moved in unison. As long as they were thus kept moving, the sound produced was continuous. A captive specimen having only a single hind leg was able to stridulate, but the note produced was feeble. During stridulation all specimens seemed to have the body somewhat distended with air. Specimens were dissected, and the air-sacs (chalky white in colour) were found to be very large. It is suggested that the sound was being amplified by the wings and body acting as a sound box. However, the air-sacs seemed to be equally well developed in the females which cannot stridulate. No evidence was obtained of the purpose served by the stridulation.

Stridulation, as a rule, occurred in three consecutive periods following closely one on another and lasting respectively 20, 10 and 6 seconds. Quite frequently only the first of these was produced, or only the first and second. Very exceptionally four consecutive bursts of stridulation were heard and, although the durations of the activity given above applied to the great majority of cases, bursts lasting as much as 30, 15 and 10 seconds occasionally took place. Captive specimens stridulated very seldom during the twenty-four hours. Judging from stridulations occurring in nature, wild specimens tend to perform more frequently. This was possibly correlated with activity on the wing.

TABLE 1.

The times at which a single captive specimen of *Lamarckiana* sp. (from Tinde) stridulated and the temperature in the vicinity of the insect when the activity took place. Also data for stridulations occurring in nature during the same period.

Date. 1944, Nov.	Stridulations by captive specimen		Stridulations in nature	
	Time	Temperature (° F.)	Time	Temperature (° F.)
6	6.00 A.M.	73	6.20 A.M.	72
	6.30 ,,	73		
7	5.45 ,,	72		
	6.05 ,,	72		
	6.25 ,,	72		
8	3.05 ,,	75	7 sets between 4.50 A.M. and 6.00 A.M.	72
	4.30 ,,	75		
	6.30 ,,	74		
9	3.10 ,,	75		
	4.25 ,,	75	5.00 A.M.	73
10	3.50 ,,	75		
	4.20 ,,	75		
	5.00 ,,	74	4.45 ,,	72
	5.20 ,,	74		
	5.40 ,,	74		
11	3.50 ,,	75		
	4.20 ,,	75	6.30 ,,	74
12	5.00 ,,	74		
	5.45 ,,	74	6.00 ,,	73
13	3.00 ,,	73		
	5.00 ,,	73		
	5.30 ,,	73		
14	6.00 ,,	74		
	7.15 ,,	74	5.48 ,,	73
15	5.30 ,,	72	6.25 ,,	70
			6.30 ,,	70
16	4.45 ,,	74	4.50 ,,	72
			4.55 ,,	72
			5.02 ,,	72
			5.10 ,,	72
17	6.00 ,,	73	6.05 ,,	73
			6.09 ,,	73
18	4.00 ,,	72	nil	69 ‡
19	4.00 ,,	73	16 sets between 4.00 A.M. and 7.00 A.M.†	71
	6.00 P.M. *	78		
20	3.00 A.M.	72		
	5.00 ,,	72		
21	6.00 ,,	72		
	6.07 ,,	72	22 sets between 4.00 A.M. and 5.50 A.M. †	69
	6.13 ,,	72		
	6.20 ,,	72		
22	nil	—	nil	‡
23	4.30 ,,	71	15 sets between 6.00 A.M. and 6.30 A.M.†	69
24	5.50 ,,	70	4 sets between 6.00 A.M. and 6.25 A.M.	68
26	6.30 ,,	70	18 sets between 4.30 A.M. and 5.45 A.M.†	68

Note.—The times given are East African standard time, which is three hours ahead of Greenwich Mean Time. It was dark, with the faintest indications of dawn at 6.00 A.M., moderately light by 6.30 A.M., and fully light by 7.00 A.M.

* A single stridulation lasting 4 seconds.

† Fine still moonlight night with scattered clouds.

‡ Raining hard.

On 2.xii.44 at 5.30 A.M. (while still quite dark) a specimen was heard which stridulated with a peculiar note, so that it could be distinguished. Judging from the sound, this individual made seven sets of stridulation in the space of half an hour, at varying distances, presumably having flown from one point of the Manyara hedge to another.

Captive specimens were kept under observation in a room near an open window. The times at which stridulation occurred as well as the temperature in the vicinity of the insect at the time were noted. When specimens were heard stridulating in nature, the time at which the activity occurred and the outside temperature were also noted. Examples of data obtained are given in Table 1. They relate to a single captive specimen and stridulations heard occurring in nature over the same period.

The table shows that in November stridulation took place chiefly before dawn (when the temperatures were at their minimum). During late October, a good deal of stridulation, both in nature and in captivity, was also noted to take place up to 8 A.M. Thus, generally speaking, it appears that the dominant period for stridulation to take place at Tinde was between 5 A.M. and 8 A.M. Between 9 A.M. and 3 A.M. the following morning, the sound was only to be heard very exceptionally. In contrast with *Lamarckiana*, my experience of *Saussurea stuhlmanniana* Karsch indicated that this species stridulated only during the day, chiefly between 10 A.M. and sunset.

Egg Pod.—During the latter half of November 1944, *Lamarckiana* females freely deposited their egg pods in the sandy soil at the bottom of empty tins in which they were kept. Examples are shown in Plate 1, fig. 4. A description of the egg pod and the egg was made from this material by Dr. B. P. Uvarov, as follows :—

" Moderately elongate, more or less curved, weakly inflated basally, rounded at bottom. Walls thin, membranous, covered by a thick and hard layer of firmly cemented sand grains. The upper two-thirds filled by light brown cellular mass. Eggs about 80 in number, placed vertically in three irregular layers, cylindrical, weakly curved, straw coloured; chorion with a dense network of low ridges forming irregularly rounded cells of somewhat varying size. Length of pod 46 mm.; diameter in the upper part 12 mm.; length of egg 8 mm.; diameter 1·5 mm."

A Parasite of Adult Lamarckiana.—On 1.x.44 an adult male *Lamarckiana* sp. (from Tinde) was observed lying dead in its cage. Its body was opened up and 8 adult dipterous maggots were found. These pupated between damp blotting-paper contained in a tin. Two imagos emerged on 13.x.44 and the rest on 14.x.44. The parasite was identified as *Blaesoxipha anceps* Villeneuve by Dr. van Emden. This was the only instance among some scores of specimens examined.

Acknowledgements.—I am greatly indebted to Dr. B. P. Uvarov for his stimulating advice and help. Also to Prof. C. H. O'Donoghue of Reading University for placing at my disposal the facilities for making the illustrations and to Mr. F. C. Padley for taking the photographs.

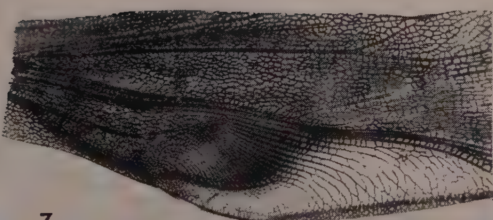
PLATE 1.

Lamarckiana sp. (from Tinde).

FIG. 1. Male in stridulating attitude (× 1). Showing modified area which acts as a rasp (R).
2. Female (× 1).
3. Portion of left male elytron showing specialised subcostal area (× 2).
4. Egg pods (× 1).

1

2



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4

E. Burtt. *Lamarckiana* sp. (from Tinde).

LARVAE OF THE BRITISH TRICHOPTERA. 22

By N. E. Hickin, Ph.D., F.R.E.S.

Molanna angustata Curtis (Molannidae).

This caddis is a widely-distributed species, occurring commonly where its typical larval habitat is found. The latter consists of lakes, pools, and slow-moving rivers and streams, with a bottom consisting of patches of sand and light gravel. In many of such localities phanerogamic vegetation is absent.

In 1943, it was found in unusual abundance in an ornamental pool used for model yacht racing at Bournville, Birmingham. This pool is slightly less than

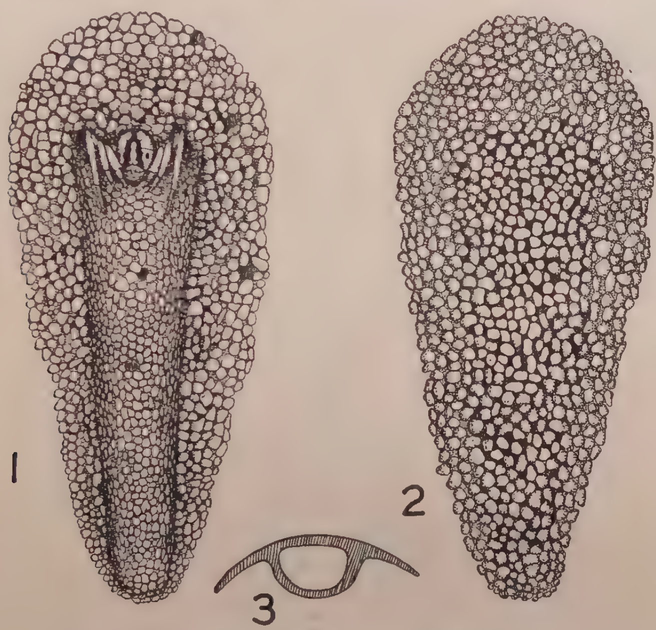

Fig. 1.—*Molanna angustata* : larval case, ventral view.
Fig. 2.—*Molanna angustata* : larval case, dorsal view.
Fig. 3.—*Molanna angustata* : larval case, transverse section through centre.

two acres in extent, with a depth of 1 ft. 8 in. at the sides, sloping to 2 ft. 3 in. at the centre. At the time of the emergence of the *M. angustata* adults, the pupal skins were piled up against one end of the pool in many tens of thousands, and gave the appearance of a band of foam about 30 ft. long, and about 3 to 4 in. deep. Much of the pool bottom consists of the old disused larval cases, and it seems highly probable that some of the old cases are utilised by the larvae in the construction of new cases.

During the winter and spring any haphazard sweep with a pond net along the pool bottom will bring a large number of old cases and a few inhabited cases to the side. The specimens from which the following description was made were collected on 26th March, 1944.

Case (figs. 1, 2 and 3) of unusual characteristic design, and constructed entirely of sand grains, cemented together with secretion, shield-shaped and convex, with a central conical

tube, the anterior opening of which is about 3 mm. diameter. The wings of the case extend forwards as a hood over the anterior opening. Length of case up to 26 mm., width 12 mm. Very often, however, the lateral wings break off or become damaged.

Larva is of eruciform type, but has some characteristics of the sub-eruciform type (cf. PHRYGANEIDAE). Up to 17 mm. in length, and 2·7 mm. in width.

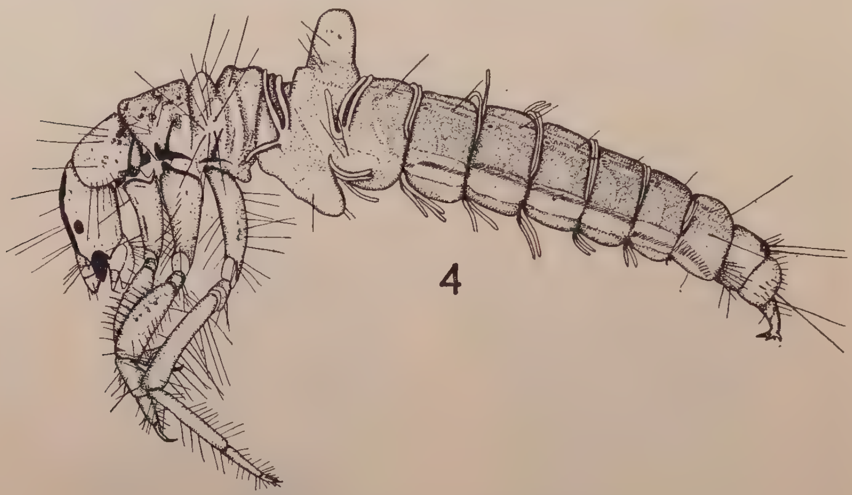

FIG. 4.—*Molanna angustata* : lateral view of larva.

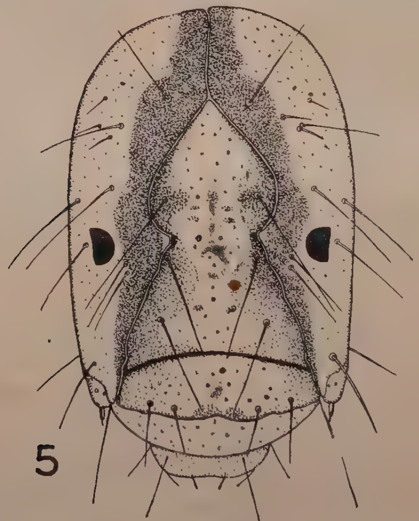

FIG. 5.—*Molanna angustata* : head of larva.

Head (fig. 5) long, light yellowish-brown, with a black band running from the dorsal cervical area of the genae to the aboral apex of the clypeus, then dividing with an arm running on each side of the clypeus. A narrow black bar divides the clypeus transversely near the oral end. Anterior margin of clypeus excised. Antennae of two segments, proximal large and bulbous, with pit-like sense organs present; distal small, and surmounted by a bristle; anteclypeus pale. Chaetotaxy as in fig. 5.

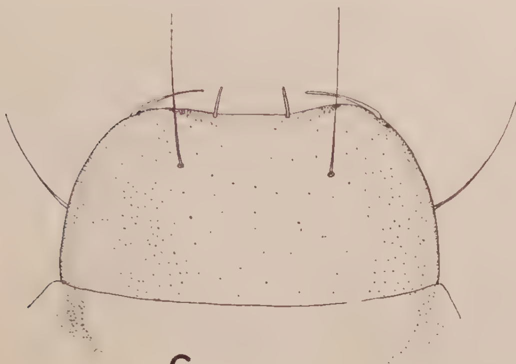

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FIG. 6.—*Molanna angustata* : labrum of larva.

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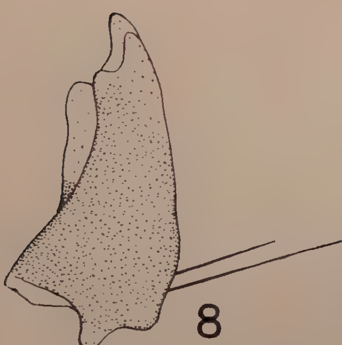
FIG. 7.—*Molanna angustata* : maxillae and labium of larva.



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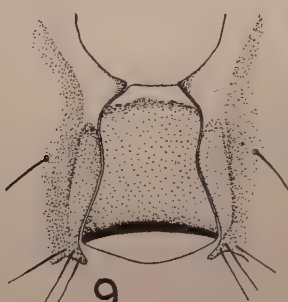

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FIG. 8.—*Molanna angustata* : left mandible of larva from beneath.
FIG. 9.—*Molanna angustata* : gular sclerite of larva.

Labrum (fig. 6). Excision on lateral margin shallow, with pair of short blunt spines at centre, and longer inwardly-directed spines at outer angles. Hairy tracts restricted to ventral surface. *Mandible* (fig. 8): both mandibles with two stout bristles at the base of the outer edge. Brush of hairs on inner edge absent. Left mandible with four blunt teeth. Right with two.

Maxillae (fig. 7). Maxillary palp three segmented and equal in length to the mala to which it is closely adpressed. Hairy tract at base of maxilla confined to a small area. Two groups of ten long black spines on ventral surface of mentum. *Labium* (fig. 7). Labial palps with one segment only apparent, but with sense organs giving bifid appearance at the tips.

Gular sclerite (fig. 9): bell-shaped, completely dividing the genae, a black transverse bar across the oral end. The regions of the genae, adjacent to the gular sclerite, show fold-like darker coloured regions, somewhat variable in size and depth of colour.

Thorax. Prothoracic notum sclerotised, divided by a longitudinal median suture.

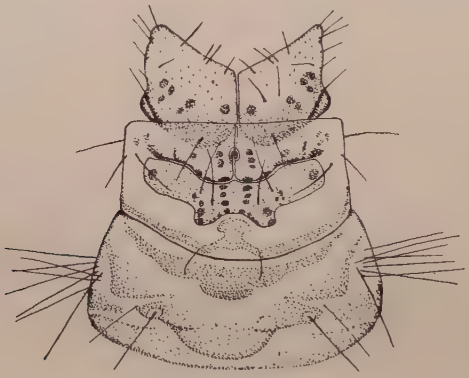

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Fig. 10.—*Molanna angustata*: thoracic nota of larva.

Mesothoracic notum with two large sclerotised areas divided by a transverse suture, the anterior area subdivided by a longitudinal suture. The posterior area is not subdivided, and has a pair of laterally-projecting lobes on each side, the anterior being much larger than the posterior. The metathoracic notum is unsclerotised.

Legs (fig. 11, a, b, c, and d). Prothoracic legs short and deep. Ventral spine of tibia set on prolongation as long as the spine itself. Mesothoracic legs intermediate in length; femur robust and deep, as in prothoracic leg. Metathoracic legs long, slender and hairy. An incipient division of the tibia is noticeable. Tarsal claw (fig. 11, d) of metathoracic legs quite characteristic. It is beset with small spines, with a large curved spine emerging from the base of the claw, and is longer than the claw itself. When the larva is crawling only the metathoracic tarsi emerge from the overhanging hood of the case; thus, it is probable that this specialised tarsal claw is the seat of numerous sense organs.

Abdomen greyish-white in colour. Intersegmental grooves well defined. Median and lateral protuberances on first abdominal segment large. Lateral line present on third to eighth segments. On the dorsal surface of the second to the eighth segments near the anterior margin on each side there is a dark coloured spot situated in a pale area. In each of these segments also there is a pattern of white bars.

Filiform gills are present on segments I to VIII. These are in small groups of usually three gills, but there is some variation in the number of gills in each group. Only the

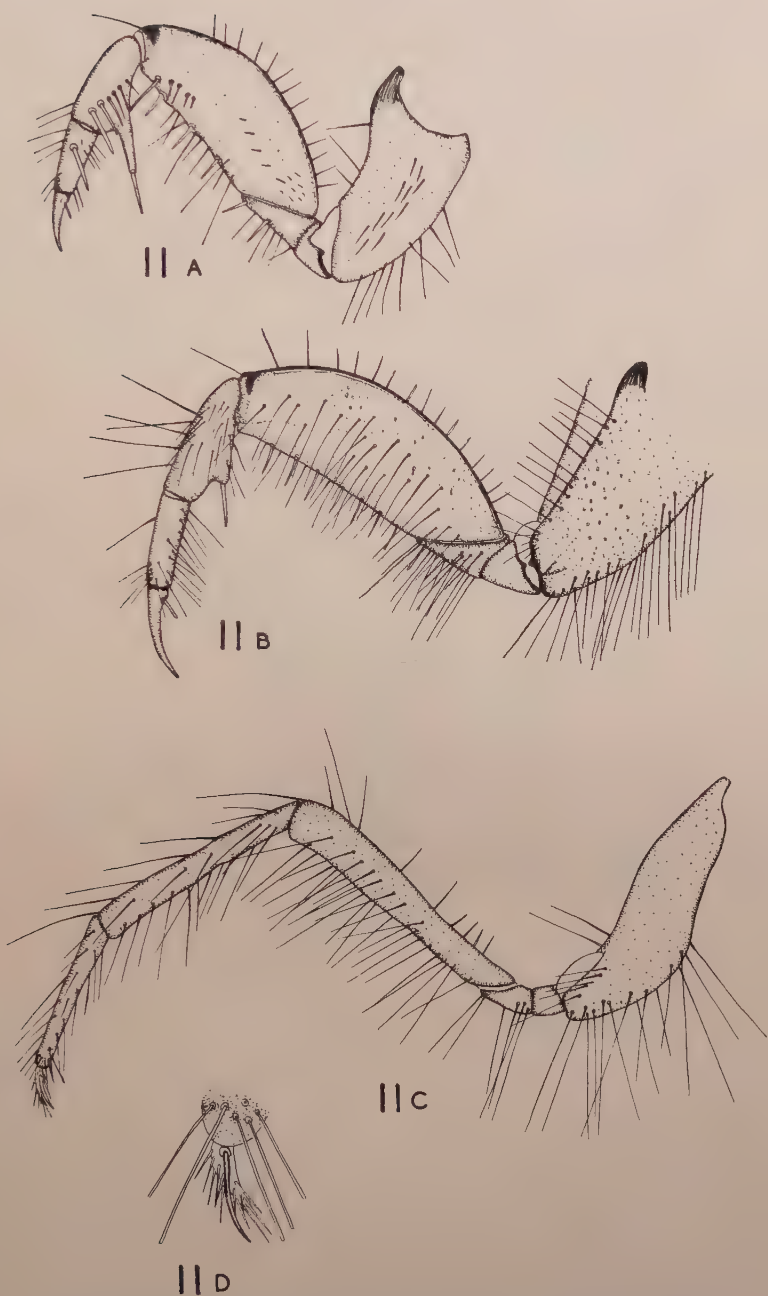

FIG. 11.—*Molanna angustata* : (a) prothoracic leg of larva ; (b) mesothoracic leg of larva ; (c) metathoracic leg of larva ; (d) tarsal claw of metathoracic leg.

dorsal gills are present on segments I and VIII. (Ulmer gives the shape of the abdomen in the subfamily MOLANNINAE as reminiscent of the PHRYGANEIDAE. This resemblance, however, is quite close in other respects, such as head pattern and abdominal protuberances, and some species of PHRYGANEIDAE are stated to have sclerotised patches on the mesonotum.)

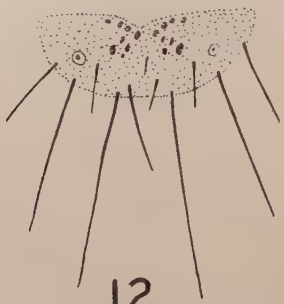

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FIG. 12.—*Molanna angustata*: anal sclerite of larva.
FIG. 13.—*Molanna angustata*: anal claw of larva.

Anal sclerite (fig. 12) not well defined, but with a few dark spots. The eye-like marks, a pair of which are found on each abdominal notum, are situated also on this sclerite. The anal claws (fig. 13) are furnished with three auxiliary claws, and in addition a number of much smaller spine-like claws at their base. The basal lobes of the claws (not shown in the figure) are also furnished with a number of curved brown spines.

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LARVAE OF THE BRITISH TRICHOPTERA. 21

By N. E. Hickin, Ph.D., F.R.E.S.

Glyphotaelius pellucidus Retzius.

Larvae of this widely-distributed Caddis Fly were collected from a small pool in Brathay Quarry Wood, near Wray Castle, Ambleside, on 27th October, 1945. This pool, from which the larvae of *Neuronia ruficrus* Scopoli and *Phryganea striata* L. were obtained in 1943, is overhung around its whole margin by oak, alder, sycamore and willow, and the cases of the *pellucidus* larvae were made up from circles cut from the fallen leaves of these trees. This species has several times been recorded in the Lake District from the capture of the

Fig. 1.—*Glyphotaelius pellucidus* : larval case from beneath.

adults, and it was doubtless this species which Moon called *Glyphotaelius punctatolineatus* in an ecological paper on material collected from Lake Windermere.

The larvae from Brathay Quarry Wood were very numerous, fifty-three being collected from about two square feet of the pond margin, where the bottom was covered completely by fallen leaves from the surrounding trees.

Case. This is quite characteristic of the larvae (fig. 1). It consists of pieces of the leaves of trees often cut in almost perfect circles, or quite commonly whole leaves of some trees are used (hawthorn). The pieces of cut leaf are arranged in two horizontal series between which a tube is constructed of small pieces of vegetable debris, cemented together with the secretion from the modified spinning gland situated in the ligula. The anterior piece of cut leaf in the dorsal series overlaps the entrance to the tube; the anterior piece in the ventral series is situated just posterior to the entrance. From the dorsal aspect of

the cased larva nothing can be seen of the larva as it moves jerkily across the submerged leaves under its mantle.

Larva is of eruciform type. Head and thorax light brown, marked with dark brown. Abdomen creamish, with gut contents showing through integument. Length 23 mm. Width 4 mm. *Head* (fig. 2) orthocentrous. Oval, light brown, strongly marked with dark brown. Several transverse rows of dark parts on dorsal surface. Aboral apex

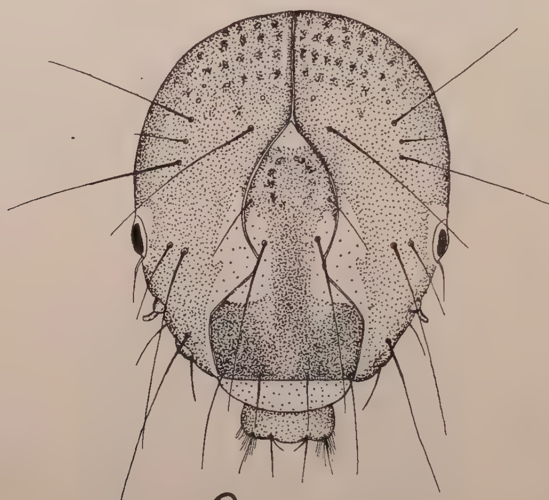

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FIG. 2.—*Glyphotaelius pellucidus*: head of larva.

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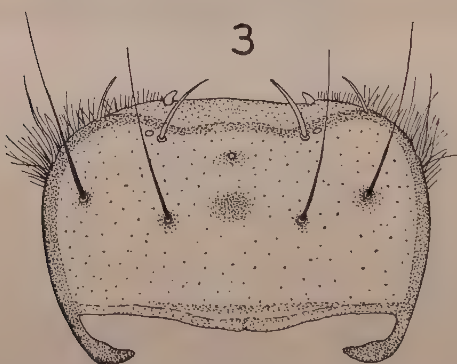

FIG. 3.—*Glyphotaelius pellucidus*: labrum of larva.

and areas adjacent to lateral excisions of clypeus light. Oral region of clypeus very darkly marked. Eyes prominent; antennae reduced. Chaetotaxy as in fig. 2. Anteclypeus pale. *Labrum* (fig. 3) transverse, light yellowish-brown, more darkly marked in chestnut brown around margin; four long, black bristles arranged transversely across the middle. *Mandible* (fig. 4) chestnut brown with black transverse band. Brush of fine bristles unequal in length on inner margin (and strong bristle at base of outer margin) of both mandibles. *Maxilla* (fig. 5) small. Palp, four segmented, bent inwards, with bunch of sense organs at tip, and a prominent circular sense organ at base of penultimate segment. At base of palp is situated a bunch of bristles as long as the palp. A group of sense organs at tip of maxilla,

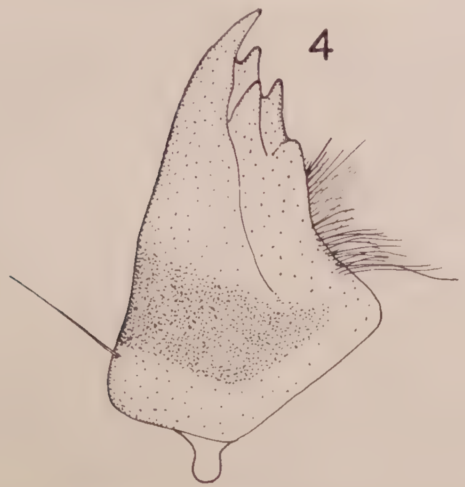

Fig. 4.—*Glyphotaelius pellucidus*: left mandible of larva.

Fig. 5.—*Glyphotaelius pellucidus*: maxilla and labium of larva.

Fig. 6.—*Glyphotaelius pellucidus*: gular sclerite of larva.

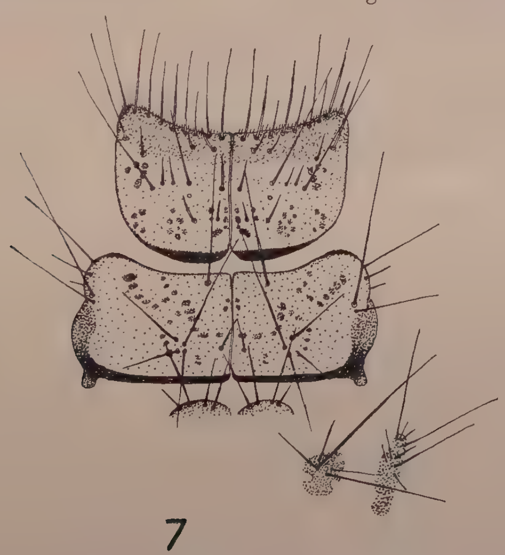

Fig. 7.—*Glyphotaelius pellucidus*: thoracic sclerites of larva.

with four blade-like bristles directed inwardly. *Labium.* Labial palps of only one segment apparent. Two rod-like organs at tip of palps. *Gular sclerite* (fig. 6) small and pear-shaped, not completely dividing the genae, but extent of aboral apex somewhat variable. *Thorax* (fig. 7). Prothoracic notum sclerotised, light chestnut in colour, with anterior third darker in colour. Median longitudinal suture present, posterior margin black.

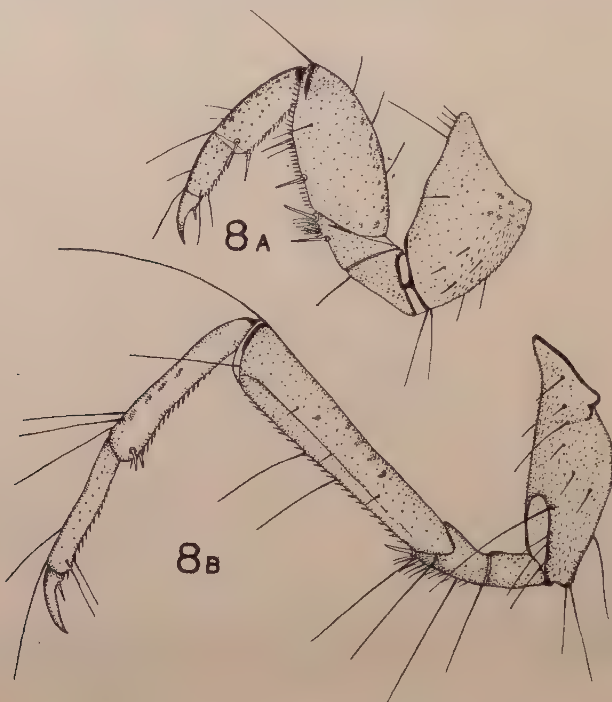

FIG. 8.—*Glyphotaelius pellucidus*: (a) prothoracic leg of larva; (b) mesothoracic leg of larva.

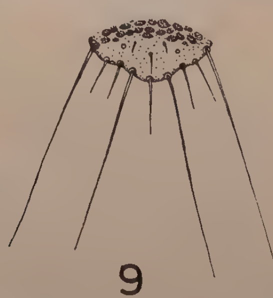

FIG. 9.—*Glyphotaelius pellucidus*: sclerite on 9th abdominal segment of larva.

Mesothoracic notum sclerotised, posterior margin black. A pattern of dark spots as in the figure. Metathoracic notum with small sclerotised patches. *Legs.* Prothoracic legs (fig. 8, a) short and deep, trochanter divided, meso- and metathoracic legs (fig. 8, b) long and thin. *Abdomen.* Protuberances on first abdominal segment present. Lateral line present on segments 3 to 8 inclusive. Basal lobes of anal claspers heavily marked in dark brown—readily visible to the naked eye. Anal claw with single auxiliary claw which is

more readily discerned when viewed from the side. Filiform abdominal gills present in bunches of three and two, united at their bases, on segments 2 to 8 inclusive. On the eighth segment, the gills consist of a united pair on the dorsal surface of each side and adjacent to the anterior margin of the segment.

Lestage (*in* Rousseau) has collected the information concerning *G. punctatolineatus* and *G. pellucidus*, and states that gills are present on segments 2 to 7 inclusive in the latter species, whilst in the former additional gills are present on the eighth segment. This certainly does not correspond with what I have found in *pellucidus*. *G. punctatolineatus* has not been found to occur in this country.

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OBSERVATIONS ON *BOMBUS AGRORUM* (FABRICIUS) (HYMEN., BOMBIDAE)

By O. W. Richards, M.A., D.Sc., F.R.E.S.

Nest 1. Under a tuft of *Deschampsia caespitosa*, at ground level, Imperial College Field Station, Slough, Bucks, 12.vii.45 (*T. Spence*). It was surrounded by chewed grass-bases but without moss. The ant, *Myrmica laevinodis* Nylander, was also nesting in the same tussock and in adjoining ones.

Commensals. *Antherophagus pallens* (Oliver) (Col., Cryptophagidae), 10. Many larvae of *Fannia* Robineau-Desvoidy sp. (Dipt., Muscidae). Acarina (det. M. E. Solomon), *Scutacarus femoris* Gros 1 ♀; *Kuzima laevis* (Degeer) (*Tyroglyphus fucorum* auct.) adults and nymphs; *Damaeus verticilipes* Nic.; *Parasitus fucorum* Degeer and *P.* spp. adults and nymphs.

Parasites. *Brachycoma devia* (Fallén) (Dipt., Tachinidae). 3 full-grown larvae and 3 puparia beneath the nest; 6 spun *Bombus*-larvae with parasite-larva attached; one dead worker pupa destroyed by the parasite.

General account. Nest taken at 7.15 a.m. (G.M.T.) by placing a glass jar over it and forcing a metal plate beneath it. Probably 6–10 workers or young queens escaped. In the next hour, 3 workers returned with pollen-loads. The site was visited again at 3.0 p.m. and 13 more workers and 2 queens obtained; on 14.vii. at 8.0 a.m. 7 workers, 1 queen and 1 ♂ were found at the nest-site. On 20.vii., 4 more workers were found in the nest-site; they had scraped together grass into a ball but there was no wax.

There were approximately 149 occupied cocoons, 27 honey-cells (old cocoons, some capped with wax), and 165 empty cocoons, with fragments of a number more.

No pockets containing pollen were found attached to the sides of the cell-mass. The eggs were found in pockets of dark brown wax about 6·0 × 4·0 mm., attached at different points to the masses of full cocoons. There were five pockets of 9, 15, 21, 21, 23, in all 89 eggs. As the larvae grow, the wax pockets are increased in size and eventually show a bulge corresponding to each larva. A mass of sticky pollen is enclosed with the larvae which are not separated from one another. Altogether 124 larvae were found; 26 just hatched, 10 small, 32 large, 56 spun (including one dead of a wilt-like disease and 6 attacked by *Brachycoma* Meade). There were therefore 68 larvae in need of feeding. The pupae found were 69 ☿, 19 ♀, 5 ♂, 93 in all. The adults present were 153 ☿ (including those taken on 20.vii.), 1 old queen, 10 young ones and 1 male.

It is usually supposed that the development of males and queens at the end of the nest-cycle is due to an increase in workers which makes it possible to feed the larvae more lavishly. No one, however, appears to have studied the larva/worker ratio though a record of its changes during the season would seem to bear on the hypothesis. In the present nest the ratio is $68/153 = 0{\cdot}44$. It is at least clear that these larvae can be better fed than the first brood of larvae, tended by a single queen.

It is also of interest to study the worker caste more closely, to see how distinctly it is separated from the queens. At the beginning of the season, when the workers are very small, there is absolute discontinuity, but as the

time of queen-production approaches, the workers get larger and it is not always easy to draw a line.

The bees were killed with ethyl acetate, the length of the fore-wing from the centre of the tegula measured to the nearest half-millimetre and the number of hooks (hamuli) on the hind-wings counted. The queens and the bigger workers were weighed; mostly 24 hours after death. It was found from the few that were weighed alive, that the dead ones might have lost 20–30% of their weight in 24 hours but it is probably legitimate to compare the figures amongst themselves. The workers were also separated into three groups—old, moderately old and fresh—according to the degree of fading of the pubescence. A fourth group of workers consisted of foragers, *i.e.* those with loads of pollen on the hind tibia and those which returned to the nest-site at intervals after the nest had been removed.

To deal first with the differences between queens and workers, the data for which are given in Tables 1–3. Table 1 gives the wing-lengths, hamuli-number, weights and the ratios weight/wing-length for the 11 queens. Table 2 gives similar data for the 149 workers, with a separate section for the 14 workers which were weighed. Finally, in Table 3, the 4 ☿ captured on 20.vii.

TABLE 1.

Wing-lengths, etc., of 11 queens of *B. agrorum*.

Wing-length (mm.)	No. hamuli	Weight (mg.)	Ratio wt./ wing-length
12·0	17, 18	390,[1] 321	32·5, 26·8
12·5	18	333	26·6
13·0	18, 19, 20	340, 313, 317	26·2, 24·0, 24·4
13·5	18, 18, 20	320, 361,[1] 424	23·7, 26·7, 31·1
14·0	19, 19	377,[2] 349	26·9, 24·9

[1] Live weight; others weighed 24 hours after death.
[2] The old queen. She had 4 + 4 enormous ovarioles. The ovaries of the other queens were very little developed.

TABLE 2.

Wing-lengths, etc., of 149 workers of *B. agrorum*.

Wing-length (mm.)		No. of speci-mens	Hamuli		Workers dissected		
Range	Mean		Range	Mean	Wing-length (mm.)	Weight (mg.)	Ratio wt./ wing-length
6·0– 8·5	8·06	18	13–17	15·9	6·0	21	3·5
9·0–10·5[3]	9·11	89	15–20	17·3	8·0	71, 77	8·9, 9·6
11·0–12·5	11·37	42	16–20	17·9	9·5	104	10·9
					10·0	128	12·8
					10·5	111	10·6
					11·0	187	17·0
					12·0	207, 216, 177	17·3, 18·0 14·8
					12·0[4]	292, 281	24·3, 23·4
					12·5	257, 225	20·6,[4] 18·0

[3] Mode 10·5 (29 ☿).
[4] Live weight; others weighed 24 hours after death.

are recorded. These were weighed alive and then dissected, the ovaries removed, dried on a filter-paper and weighed on torsion-balance (calibrated in 0·05 mg.). The ovarial weight is then expressed as a percentage of body weight.

TABLE 3.

Data for workers of *B. agrorum* collected on 20.vii., weighed alive.

Wing-length (mm.)	No. hamuli	Live wt. (mg.)	Ratio wt./ wing-length	Wet wt. of ovaries (mg.)	Ovaries as % of live wt.
9·5	16	106	11·2	2·0	1·9
10·0	18	124	12·4	1·6	1·3
10·5	19	190	18·1	6·1	3·2
12·0	18	281	23·4	4·0	1·4

Although queens and workers overlap in wing-length, queens could be recognised by their bulkier appearance, and this is confirmed when they are weighed. Though the weights of queens and workers are actually discontinuous, the data on this point are insufficient since the gap is small. The ovaries of young females do not differ materially from those of large workers. The data for the ratio weight/wing-length show rather less discontinuity.

The analysis of the workers is shown in Table 4.

TABLE 4.

149 workers of *B. agrorum*, classified into worn, moderately worn, fresh and foragers (= specimens with pollen or specimens returning later to nest-site).

A. Worn			B. Moderately worn			C. Fresh		
No.	Wing-length (mm.). Range and mean	Hamuli. Range and mean	No.	Wing-length (mm.). Range and mean	Hamuli. Range and mean	No.	Wing-length (mm.). Range and mean	Hamuli. Range and mean
				In the nest.				
6	7·5–10·0 8·7	15–17 16·0	30	6·0–10·5 9·3	13–19 17·1	85	7·5–12·5 10·4	15–20 17·4
				Foragers.				
5	9·5–12·0 10·4	16–20 17·2	5	9·5–11·0 10·2	17–19 18·0	18	9·5–12·0 10·6	16–20 18·2

The analysis of the workers clearly shows that the fresher workers are larger, suggesting a progressive change with the development of the colony. This is shown best in those captured in the nest. The foragers, on the other hand, are larger individuals and the data suggest a division of labour. The smaller workers, which are quite common in the nest, resemble foraging workers of the first brood but later in the season they probably devote themselves mainly to nursing and nest-construction.

Nest 2. At ground level, in rough grass in field adjacent to Field Station, Slough, 29.viii.45 (*T. Spence*). Nest of dry cut grass about 25 cm. diameter and 7·5 cm. high, in a clearing in the grass of the same size.

COMMENSALS. Four large larvae of *Volucella* Geoffroy sp. (Dipt., SYRPHIDAE).

Parasites. Four full and four empty puparia of *Brachycoma devia* (Fallén) (Dipt., Tachinidae).

General account. Nest taken at 9.0 a.m. (G.M.T.) on a dull, damp day. Only one or two workers escaped at the time, but 13 workers were captured an hour later, flying over the site. The nest contained 28 (13 + 15) eggs, 18 just hatched, 20 small, 31 moderate and 26 large (= 95) larvae, 3 larvae dead of " wilt " (black and soft), 81 spun larvae, and 13 pupae. There were 102 honey-cells (in old cocoons) and a few old empty cocoons. No old queen was found and she had probably died some time earlier as no young queens were found. There were 78 workers and 17 males, mostly very young. The larva/worker ratio was therefore 1·22.

The bees were weighed alive and measured, but only a few were dissected. The results are shown in Table 5.

Table 5.

Wing-lengths, etc., of 78 workers and 13 males of *B. agrorum.*

	Worn			Moderately worn			Fresh		
	No. 13			No. 36			No. 16		
	Wing-length = *A*	Weight = *B*	*B/A*	Wing-length = *A*	Weight = *B*	*B/A*	Wing-length = *A*	Weight = *B*	*B/A*
Workers in the nest.									
Range	6·5–10·0	37·5–110	5·8–11·0	6·5–11·5	48–190	7·4–16·5	7·5–10·0	70–128	8·4–13·6
Mean	7·9	66·6	8·3	8·5	91·2	10·5	9·0	103·6	11·5
Hamuli	14–18, 16·0			12–21, 16·9			14–19, 17·1		
Foragers.									
	No. 7			No. 6			No. 0		
Range	9·5–10·0	99–137	10·4–13·8	9·0–10·5	108·5–154	10·9–14·7			
Mean	9·7	119·1	12·2	9·8	124·3	12·7			
Hamuli	16–19, 17·9			17–19, 18·3					

Males in the nest.

	Wing-length	Weight	Wt./wing-length	Hamuli
Range . . .	10·5–12·0	125–180	11·2–16·4	17–20
Mean . . .	11·3	155·1	13·7	18·2

It can be seen that there is the same tendency as in Nest 1 for the older workers to be smaller and for the foragers to be particularly large. It may be that in both nests there is a real tendency for foragers to have a number of hamuli which is high even allowing for their larger size. Alpatov (1929, *Quart. Rev. Biol.* **4** : 1–58), in the honey-bee, has suggested that an increase in number of hamuli is associated with the need for flying longer distances.

It is probable that in Nest 2, owing to the absence of the old queen, some of the workers had started laying. The ten largest ones were dissected; in 7 the ovaries were rudimentary, but in 3 there were 2, 2 and 6 ripe eggs. The last-named specimen, which weighed 190 mg. and was moderately worn, had almost certainly been laying.

Nest 3. At ground level, in long grass (*Dactylis*, etc.), in garden, Slough, 13.ix.45 (*G. Fraenkel*). The nest had an exposed dome of cut grass 15 cm. diameter, 6·0 cm. high. The nest was taken at 8·30 A.M. (G.M.T.) and only one or two bees escaped. The comb was roughly circular, 10·0 cm. diameter. The nest contained no parasites but there were the following commensals :—*Epuraea depressa* Gyllenhal (Col., NITIDULIDAE) 3; *Xantholinus linearis* (Olivier) (Col., STAPHYLINIDAE) 2; *Blacus paganus* Haliday (Hym., BRACONIDAE) 1 ♀; also 1 dead ♂ *Apanteles* Foerster (BRACONIDAE).

The occupied cells were roughly arranged in two layers. There were two wax pockets of 7 + 15 = 22 eggs; there was no pollen in these pockets. There were groups of 16 medium and 10 large larvae (= 26). Seventy-seven cocoons contained spun larvae or pupae. Twenty-eight old cocoons contained honey, four of them completely capped with wax. In the lower layer, most of the cocoons were empty or contained honey but a few contained worker pupae.

At 8.30 A.M. on 13.ix., 46 ☿, 5 queens, 7 males were captured. At 1.0 P.M., 6 ☿, 1 ♀ were caught on the site. On the morning of 14.ix., 7 more workers were captured. There were thus 59 workers in all and the larva/worker ratio was 0·36. The bees were all weighed alive, then killed and measured and 53 queens and workers were dissected. In this nest also there was no old queen, though two of the young queens had been fertilised. A complication occurred, not noticed before, in that some of the bees had been gorging on honey, making themselves unduly heavy. This could be detected by opening the honey-sac, but no allowance has been made for it. A summary of the measurements and dissections is given in Table 6. These show, as before, that the fresher specimens are heavier, with longer wings and more hamuli. The foragers, except

TABLE 6.

Summary of weights, wing-lengths, etc., of bees in nest 3.

	No.	Wing-length		Weight		Hamuli		Ovaries.[5] No. with some ripe eggs	Mean % of body wt.
		Range	Mean	Range	Mean	Range	Mean		
In the nest.									
Worn workers	21	6·5–11·5	8·9	53–147	98·6	14–20	17·2	0	1·09
Mod. worn	16	7·0–11·0	9·2	65–198	113·9	15–20	17·7	2	1·99
Fresh	9	10·0–12·0	11·2	172–253	211·8	18–22	19·7	2	2·54
Foragers.									
Worn	9	10·0–11·5	10·4	101–221	149·8	17–21	19·1	0	0·48
Mod. worn	6	10·0–11·0	10·6	101–252	160·3	18–20	18·8	0	0·42
Fresh	6	11·0–12·0	11·4	176–235	202·3	18–21	19·3	2	1·78
Queens	6	12·5–13·5	13·0	280–434	355·7	19–22	20·3	0	0·90
Males	7	9·0–11·5	10·5	139–193	160·7	16–18	16·9	—	—

[5] The following numbers of each group were dissected :—in nest, 10 worn, 10 mod. worn, 7 fresh; foragers, all; queens, 5.

in the fresh bees, are larger than bees found in the nest. The young queens are larger still and in this nest quite discontinuous from the workers in weight; whether fertilised or not, their ovaries are little developed. Workers found in the nest, probably because of the absence of the old queen, are showing a tendency to ovarial development. There is a strong suggestion, however, that this is suppressed in foragers. A study of the individual workers found in the nest shows that the averages are much affected by a relatively few indivi-

duals with large ovaries; these were probably the laying individuals. This is shown in Table 7, which shows the frequency of different degrees of ovarial development (*i.e.* ovary wt. as % of body-weight).

TABLE 7.

Ovary as % of body weight	0·3–0·5	0·6–0·9	1·3–3·2	5·1–7·7
Frequency (all workers)	20	16	7	5
No. with some ripe eggs	0	0	1 [6]	5

[6] 4 with some eggs $\frac{1}{2}$–$\frac{3}{4}$ ripe.

Although fresher bees are larger and have better developed ovaries, there seems to be no definite relation between size and ovarial development within the four categories of worker recognised in Table 6.

SUMMARY.

1. Data are given for the number of larvae tended by known numbers of workers.

2. It is shown that queens and workers can be separated best by weighing them.

3. In three nests, it is shown that old worn workers are smaller and lighter than fresher ones. Foragers are larger than workers found in the nest and perhaps have less developed ovaries. There may be a real division of labour amongst the workers.

REARING LARVAE OF THE EYED HAWK MOTH, *SMERINTHUS OCELLATUS* (L.) (LEP., SPHINGIDAE), ON APPLE AND SALLOW

By O. W. Richards, M.A., D.Sc., F.R.E.S.

The Eyed Hawk moth is a somewhat unusual example of a species restricted to two food-plants [1]—*Salix* spp. and apple—which are not at all allied to one another botanically. On 25.v.45 I was given a tin containing a female of the moth which had laid a number of eggs, mostly on the tin but some on a rhubarb leaf. The eggs hatched on 4–5.vi. and 76 larvae were obtained. These were made up into four lots of 19 each in two-pound jam jars, two lots on sallow (probably *S. cinerea*) and two lots on cultivated apple leaves. By 27.vi. the larvae were half-grown and it was noticeable that those which had fed on apple were whiter [2] than those fed on sallow. There were 30 survivors of each type. Their food preferences were then tested by putting them on fresh leaves for 24 hours and counting the number of frass pellets on three successive days. Probably owing to a fall in the temperature over this period, the total amount of feeding fell irrespective of the treatment. The groups of larvae 1–4 started each with 15, but ended up on 30.vi. with 14, 14, 15, 13. The deaths were largely due to the disturbance of moulting larvae, but the figures for "frass-pellets per larva" in the table are based on the number of larvae alive at the end of each period.

Table 1.

Number of frass-pellets produced by larvae on different foods. S = Sallow; A = Apple.

	4–27.vi.	27–8.vi.			28–9.vi.			29–30.vi.		
Group no.	Food.	Food.	Pellets.	Pellets per larva.	Food.	Pellets.	Pellets per larva.	Food.	Pellets.	Pellets per larva.
1	S	S	286	19·1	S	198	13·2	A	120	8·6
2	S	A	202	13·5	A	136	9·7	S	191	13·6
3	A	A	245	16·3	A	129	8·6	S	101	6·7
4	A	S	278	18·5	S	207	14·8	A	126	9·7

The only evident result of the experiment is that larvae given sallow produce more pellets; this may mean it is a preferred food. There is no evidence that the nature of the food in the first three weeks of life seriously alters their preferences.

[1] A full list of food-plants is given by Tutt (1902, *Brit. Lepid.* **3** : 441).

[2] A long discussion of the colour of the larva will be found *in* Poulton (1885, *Proc. R. Soc.* **38** : 269–315) and Poulton (1886, *Proc. R. Soc.* **40** : 135–73).

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" November 6, 20
" December 4

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